WESPINE P*inus pinaster* and *P. radiata* resource trials. IV. Final report

This report summarizes the results of analysis of the WESPINE P. radiata and P. pinaster trials.

Two features account for most of the differences between the two species. First, P. pinaster has many more large knots (ie knots > 40 mm diameter) and this seems to be a major contributing factor to downgrading by the machine stress grader. Large knots are also known to be a cause of downgrading by visual assessment. However, most of the knots in P. pinaster were sound, more so than in P. radiata. Second, the presence of heart in P. radiata boards is the major factor causing downgrading by the machine stress grader. Large knots are not as prevalent, but the more deleterious knot types (loose or encased knots, knot and cone holes) are more frequent.

Overall, P. pinaster had slightly fewer knots than P. radiata (see Table 1) but about four times as many large knots. There were 30% fewer of the more damaging knot types. P. pinaster had about 25% more combined large and damaging knots than P. radiata.

The distribution of knots within the bole differed between species and between resources (see Table 2). In P. radiata, there were more knots in mid and top logs (over all resources, this was almost 2:1). This was particularly so for some resources, eg R82. In P. pinaster the same trend was present but much less pronounced (overall, about 1.5:1). In average size, knots in P. pinaster were around 30% larger.

Sixty-five of the 799 P. radiata boards (8.1%) examined were graded non-structural by the machine stress grader, almost twice the rate for P. pinaster (4.4%). However, board lengths differed between the two species and some of the longer P. radiata boards (those over 4.8m length) were more frequently downgraded. The overall higher rate in P. radiata was largely due to a very high rate in the R83 resources. For the other resources, the rate of downgrading differed only slightly between species.

The factors related to downgrading were the same for both species. Boards were more likely to be downgraded by the machine stress grader if they were from mid or top logs, had heart-in, or bore many or large knots. However, the degree to which each of these factors increased risk of downgrading was quite variable. In P. radiata, boards with heart-in had an estimated sixteen-fold increase risk of downgrading. Boards from top and mid logs were 4x more at risk than those from butt logs.The R83 resource was also identified as being at 3x increased risk.

In P. pinaster, boards with heart-in or from top and mid logs were 3x as likely to be downgraded, indicating that heart-in P. pinaster boards are stronger than their P. radiata equivalent. The presence of particularly large knots (>45mm diameter) doubled the risk of downgrading.

If the RP76 resource is taken as the standard, with a downgrading rate of 1, then the various resources rated as follows (see Table 4): The RP73 and RP75 resources were best at under 2, R81 and R82 were next at around 2.3, RP74 was weaker at 3.6 and the R83 was worst, at over 7 the rate.

Table 1. Observed numbers of knots per 10 m of board (top line, actual numbers below), average knot size (mm), total numbers of boards examined and frequency of downgrading by machine stress grader, for P. radiata and P. pinaster resources.

	P. radiata resources				P. pinaster resources				
	81	82	83	**TOTAL**	73	74	75	**76**	**TOTAL**
Large knots (>40mm diameter)	0.44 65	0.28 37	0.19 18	**0.32** **120**	1.4 248	1.7 227	1.2 184	1.2 235	**1.4** **894**
Damaging knots (Encased, Loose, Holes & Cone holes)	1.9 282	2.0 261	0.9 85	**1.7** **628**	1.3 223	0.5 74	0.7 102	1.6 315	**1.1** **714**
Subtotal (Large+Damaging)	2.2 329	2.0 259	1.1 103	**1.9** **691**	2.7 460	2.2 294	1.9 282	2.7 529	**2.4** **1565**
All knots	11.3 1580	11.5 1394	12.3 1134	**11.1** **4108**	10.6 1796	10.1 1341	10.5 1543	10.5 1978	**10.3** **6658**
Average size of knots	20.3	20.0	19.5	**20.0**	26.0	28.6	26.6	26.0	**26.7**
Total number and length of boards examined (m)	307 1480.7	268 1300.5	224 932.7	**799** **3713.9**	379 1716.0	297 1348.8	319 1473.6	461 1931.7	**1456** **6470.1**
Average board length	4.8	4.8	4.2	**4.6**	4.5	4.5	4.6	4.2	**4.4**
Number of boards downgraded by MSG	17 5.5%	14 5.2%	34 15.2%	**65** **8.1%**	15 4.0%	24 8.1%	14 4.4%	11 2.4%	**64** **4.4%**

Table 2. Prevalence of all, large and damaging knot types (encased, loose, holes and cCone holes) in boards from P. radiata and P.pinaster resources. Numbers are adjusted mean number of knots per 10 m of board.

	P. radiata resources				P. pinaster resources				
	81	82	83	**TOTAL**	73	74	75	**76**	**TOTAL**
All knots:									
Free Of Heart	9.5	10.3	12.7	**10.8**	9.6	9.4	10.6	8.3	**9.5**
Heart In	13.2	12.2	12.6	**12.6**	12.4	13.7	12.3	13.2	**12.9**
Butt logs	8.4	6.8	11.2	**8.8**	9.7	9.9	10.4	8.0	**9.5**
Mid & top logs	14.4	15.6	14.1	**14.7**	12.3	13.1	12.6	13.6	**12.9**
Large knots:									
Free Of Heart	0.5	0.1	0.2	**0.3**	2.5	2.1	1.7	1.1	**1.9**
Heart In	0.4	0.5	0.2	**0.4**	0.9	0.9	1.0	1.2	**1.0**
Butt logs	0.2	0.4	0.1	**0.2**	0.4	1.2	1.0	0.5	**0.8**
Mid & top logs	0.7	0.3	0.3	**0.4**	3.0	1.8	1.8	1.8	**2.1**
Damaging knots:									
Free Of Heart	2.5	2.5	1.1	**2.0**	1.7	0.6	0.8	1.8	**1.2**
Heart In	0.4	1.3	0.5	**0.8**	0.7	0.1	0.4	0.8	**0.5**
Butt logs	1.2	1.3	1.0	**1.2**	1.7	0.7	0.7	0.4	**0.9**
Mid & top logs	1.8	2.5	0.6	**1.6**	0.7	0.1	0.5	2.2	**0.9**

Table 3. Risk factors related to downgrading, identified by multivariate logistic regression using stepwise selection. The odds ratios (in **bold type**) indicate the increase in risk of downgrading by the machine stress grader associated with the precence of the predictor variable (eg, P.radiata boards with heart-in are 16 times more likely to be graded to non structural than free-of-heart boards).

	P. radiata				**P.pinaster**				
Predictor variables, both species	**additional predictors**	**Parameter estimate**	**Std error**	**Odds ratio**	**additional predictors**	**Parameter estimate**	**Std error**	**Odds ratio**	
Intercept		-5.8	0.62			-5.7	0.48		
Sum of knot diameters		0.014	0.003			0.0049	0.002		
Heart in		2.79	0.45	**16.3**		1.07	0.28	**2.9**	
Top log		1.50	0.33	**4.5**		1.10	0.32	**3.0**	
	R83	1.07	0.33	**2.9**	R74	1.39	0.31	**4.0**	
					R75	0.83	0.36	**3.0**	
					Knot >45mm diam	0.66	0.30	**1.9**	

Table 4. Comparison of downgrading rates amongst resources, identified by multivariate logistic regression. The RP76 resource has been taken as the standard. The odds ratios (in **bold type**) indicate the increase in risk of downgrading by the machine stress grader, associated with each resource (eg, P.radiata boards from the R81 resource were 2.4 times more likely to be graded non structural, than boards from the RP76 resource).

Predictor variables, both species	**Parameter estimate**	**Std error**	**Odds ratio**
Intercept	-3.7	0.31	
RP73	0.5	0.4	**1.7**
RP74	1.3	0.4	**3.6**
RP75	0.6	0.4	**1.9**
R81	0.9	0.4	**2.4**
R82	0.8	0.4	**2.3**
R83	2.0	0.4	**7.3**